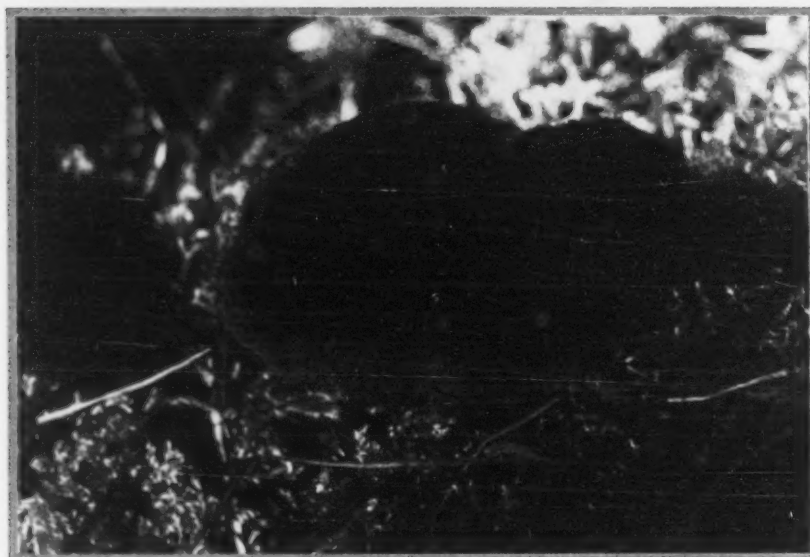


Recovery Strategy for the Pacific Water Shrew (*Sorex bendirii*) in British Columbia



Prepared by the Pacific Water Shrew Recovery Team



Ministry of
Environment

June 2009

About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

This recovery strategy has been prepared by the Pacific Water Shrew Recovery Team, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The British Columbia Ministry of Environment has received this advice as part of fulfilling their commitments under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada - British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Pacific Water Shrew populations in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the recovery team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the recovery team.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of Pacific Water Shrew.

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The British Columbia Ministry of Environment is responsible for producing a recovery strategy for the Pacific Water Shrew under the *Accord for the Protection of Species at Risk in Canada*. Environment Canada's Canadian Wildlife Service also participated in the preparation of this recovery strategy.

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EXECUTIVE SUMMARY

The Pacific Water Shrew, *Sorex bendirii*, is a semiaquatic riparian habitat specialist whose range in Canada is limited to approximately 5700 km² in the highly urbanized landscape of the Lower Mainland/Fraser Valley of British Columbia (B.C.). This mammal was designated as Endangered by COSEWIC in 2006. Increasing urbanization and associated effects such as road-building and pollution, forestry on Crown land, and agricultural activities are reducing the amount of suitable habitat available for the Pacific Water Shrew. Habitat loss, degradation, and fragmentation from urban development, forestry, and agriculture are the primary threats to the species in Canada. Additional potential threats include aquatic pollution, mortality due to domestic cats, research mortality, and flooding.

The overall goal for recovery of the Pacific Water Shrew in B.C. is:

To halt the decline of Pacific Water Shrew and ensure a self-sustaining population within secure habitat throughout its current and historical range in Canada, where habitat still exists or can be restored (achieved within 10 years).

This goal is best addressed in two distinct parts:

Goal A: *ensure that the current B.C. population of Pacific Water Shrew is maintained with no further loss of local populations (achieve within 5 years).*

Goal B: *restore Pacific Water Shrew back to its historical range, where suitable and/or connecting habitat still exists, or can be rehabilitated, so that patterns of natural population dynamics and dispersal can be maintained or restored (achieve within 10 years).*

Specific objectives and recommended approaches to address the recovery goal are:

1. Protect all known extant sites (habitat protection and management - within 2 years).
2. Restore historical and important potential habitats (habitat restoration – within 10 years).
3. Prevent habitat fragmentation and ensure habitat connectivity (habitat connectivity, modeling, mapping and restoration—within 10 years).
4. Prevent the inadvertent loss of not yet discovered populations (surveys, modeling and mapping, information management and education/outreach—within 5 years).
5. Address immediate threats (mitigate direct mortality—within 5 years).
6. Evaluate the implemented protective measures/recovery activities (monitoring and evaluation—within 5 years).
7. Increase our understanding of the critical habitat needs, life history, population dynamics, and habitat use of the species, and clarify threats to the populations (research—within 10 years).

Widespread habitat degradation within the Canadian range of the species suggests that current habitat capability is much lower than historical levels. Some areas within the historical range of the species have been modified to the extent that rehabilitation of the habitat may not be possible. Critical habitat under the federal *Species at Risk Act* is not proposed for identification in this document. The recovery team recommends the protection of occupied habitat currently

known to be around 19 recent occurrences of the Pacific Water Shrew. Based on the current knowledge of the biological and habitat needs of Pacific Water Shrew, the areas identified for survival should include a 100-m protective area around each side the of watercourse/water bodies associated with the capture location (where habitat is available), and a stream segment at least 1.5 km long. Additional habitat areas, to be proposed for protection in the forthcoming action plan, will also be needed to support the recovery of this species. Given that the Pacific Water Shrew occurs predominantly on private lands, stewardship efforts (involving the voluntary cooperation of landowners) will be important to their conservation and recovery.

The recovery team has determined that recovery is biologically and technically feasible, providing that ongoing management intervention occurs. Intervention is required to ensure that habitat is protected and restored, and that threats are alleviated. Many opportunities exist to integrate recovery planning for the Pacific Water Shrew into other recovery efforts and larger-scale plans, such as the South Coast Conservation Program.

An action plan for Pacific Water Shrew should be completed and approved by the Pacific Water Shrew Recovery Team within 2 years of the recovery strategy being posted on the SARA public registry.

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BACKGROUND

Species Assessment Information from COSEWIC

Date of Assessment: April 2006

Common Name (population): Pacific Water Shrew

Scientific Name: *Sorex bendirii*

COSEWIC Status: Endangered

Reason for designation: The habitat of this rare species, confined to the lower Fraser Valley region of British Columbia, continues to decline and fragment as a result of development. There is little chance of rescue. It is extremely rare throughout its range.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Threatened in April 1994 and May 2000. Status re-examined and designated Endangered in April 2006. Last assessment based on an updated status report.

Description of the Species

The Pacific Water Shrew is the largest shrew in British Columbia (B.C.), and one of two semi-aquatic shrews in the province. The overall body length averages 15.4 cm, 7 cm of which is tail (Nagorsen 1996). The average weight is 13.2 g (Nagorsen 1996). The fur is dark brown to black dorsally and dark brown ventrally (Nagorsen 1996). This species has a fringe of stiff hairs on its hind feet that interlock and aid in swimming. The species is unlikely to be confused with most shrews with which it co-occurs in B.C. Terrestrial shrew species that occur within the range of Pacific Water Shrew in B.C., *Sorex cinereus*, *S. monticolus*, *S. trowbridgii*, and *S. vagrans*, are considerably smaller (average <12 cm total length, and ≤ 7 g weight; Nagorsen 1996), and lack a fringe of stiff hairs like those on the feet of the Pacific Water Shrew. The Pacific Water Shrew co-occurs with another large semi-aquatic shrew, the American Water Shrew (*S. palustris*), in a narrow portion of its range in B.C. The American Water Shrew tends to be captured at higher elevations than the Pacific Water Shrew (Nagorsen 1996). The American Water Shrew (average 15.2 cm length, 10.6 g weight; Nagorsen 1996) tends to be slightly smaller than the Pacific Water Shrew and can be distinguished by its white belly with dark grey to black dorsal fur and bi-coloured tail (paler on the ventral surface). A positive identification of Pacific Water Shrew requires trapping, which allows close examination of the features of the captured shrew.

Populations and Distribution

The range of the Pacific Water Shrew is constrained to western North America, from the coast of British Columbia south to northern California (Figure 1). Globally, the Pacific Water Shrew is ranked by NatureServe (2007) under the common name "Marsh Shrew" as apparently secure (G4). In the United States it is ranked N4 (apparently secure), and in Canada N1 (critically imperiled). In Canada, the Pacific Water Shrew is found only in British Columbia, where it is

ranked by the B.C. Conservation Data Centre (2007) as S1S2 (imperiled to critically imperiled) and is on the provincial Red list. Of the three subspecies of Pacific Water Shrew recognized in North America; *S. b. albiventer*, *S. b. bendirii*, and *S. b. palmeri*, only *S. b. bendirii* occurs in Canada. The subspecies *S. b. bendirii* also occurs in the Cascades in western Washington, Oregon, and California. The subspecies *S. b. albiventer* occurs on the Olympic Peninsula in Washington, and *S. b. palmeri* occurs along coastal Oregon. In Washington and Oregon, *Sorex bendirii* is ranked as apparently secure (S4), and in California is ranked vulnerable to apparently secure (S3S4; NatureServe 2007). Based on comparisons of mtDNA from *S. b. bendirii* and *S. b. palmeri* specimens, however, the validity of the subspecies groups is under question (O'Neill et al. 2005). Pacific Water Shrew is a priority 1 species under goal 3 of the B.C. Conservation Framework (see www.env.gov.bc.ca/conservationframework/ for details).



Figure 1. Distribution of Pacific Water Shrew in North America.

In British Columbia, the Pacific Water Shrew is known to occur from the extreme southwest corner, from Point Grey in the west, to the Chilliwack Valley in the east, and has recently been

captured as far north as Squamish (Figure 2). There are approximately 138 occurrence records (historical museum records and recent captures, Figure 2), and at least an additional 6 potential sighting records. Some of the sightings of shrews suspected to be Pacific Water Shrew suggest that the species may occur farther east than previously known; however, trapping is required to determine that the shrews sighted are Pacific Water Shrew and not the American Water Shrew, which co-occurs in the area and can be difficult to distinguish without careful examination. The estimated extent of occurrence of the Pacific Water Shrew, which includes all historical and recent captures (but not sightings), is approximately 5700 km²; its current area of occupancy is unknown (COSEWIC 2006).

The Pacific Water Shrew is known largely from elevations records below 650 meters in BC. However, this maybe a sampling biased as it has been discovered as high as 850 meters elevation in Mount Seymour Provincial Park (Nagorson 1996) and up to 1330 meters in the Cascades (Pattie 1969). Currently the best management practices guidelines recommend that sites ≤ 1000 m in elevation be assessed for Pacific Water Shrew (Craig and Vennesland 2007).

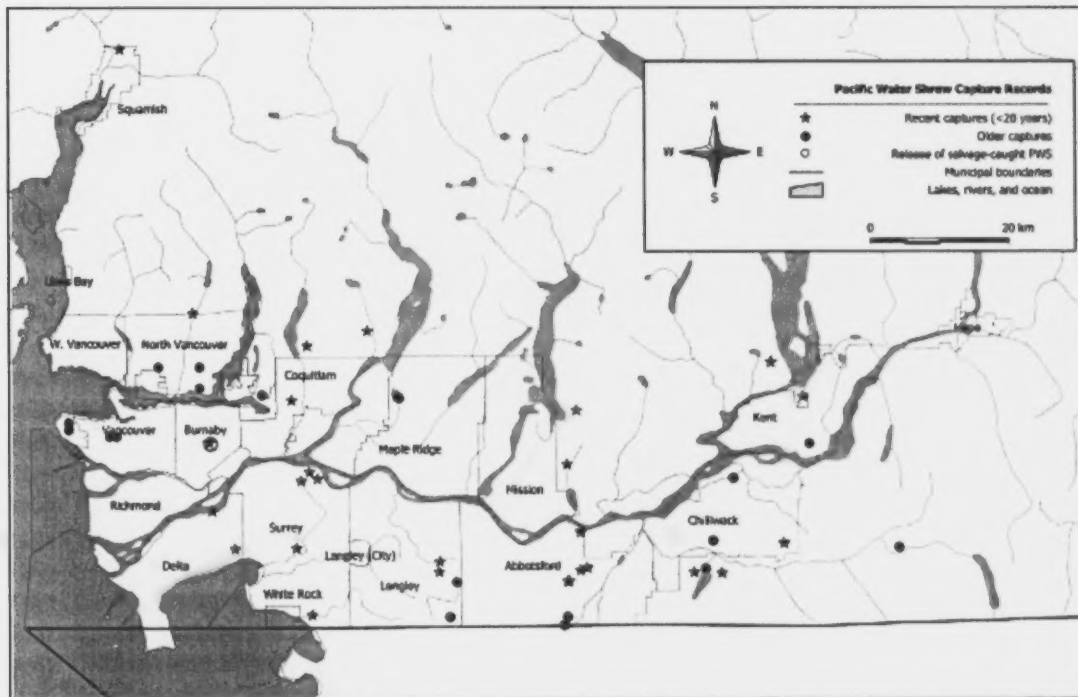


Figure 2. Location of Pacific Water Shrew capture records in British Columbia. The known range of the shrew has expanded with the recent capture of 2 Pacific Water Shrews in Squamish.

Information on trends in Pacific Water Shrew abundance or population dynamics (including reproductive, growth, and survival rates), requires repeated intensive live-trapping and does not currently exist. The majority of captures in the past have been incidental or, more recently, associated with environmental assessments using a protocol that precludes assessments of abundance. Two studies provide some information on presence-absence and sampling effort (COSEWIC 2006). Seip and Savard (Seip and Savard 1990; and Seip unpublished data cited in

COSEWIC 2006) conducted a small mammal survey using a variety of techniques. They surveyed 22 sites in different-aged forests in the Seymour, Capilano, and Coquitlam watersheds with 3 trap types (28,340 trap-nights) but captured only 5 Pacific Water Shrews at 2 sites. Zuleta and Galindo-Leal (1994) sampled 55 sites at 39 locations across the known range of the Pacific Water Shrew (19,810 trap-nights using pitfall traps), but captured only 3 Pacific Water Shrews. Unfortunately, neither of these studies provided information about trap placement (distance from water, distance from downed wood), which can influence trapping success (D. Knopp, pers. comm., 2007). The data available on capture success versus trapping effort from numerous studies suggest that the species is rare across its range (COSEWIC 2006).

Although the trend in Pacific Water Shrew abundance is unknown, it is likely declining along with declines in availability of freshwater suitable habitat within its range (COSEWIC 2006). Boyle et al. (1997) estimated that 87% of wetlands in the lower mainland were lost between the 1820s and 1990s. Moore et al. (2003) examined orthophotos of 320 wetlands taken in 1989 and 1999 and documented encroachment of, and habitat loss at, 22% of the wetlands. In addition, Fisheries and Oceans Canada (1997) examined freshwater streams in the lower mainland and classified only 14% as remaining in their wild (undegraded) state. Fifteen percent were classified as lost (paved or culverted), 23% classified as Threatened and the remaining 48% classified as Endangered based on the degree of habitat degradation. Rescue of the species from adjacent populations in Washington is unlikely because of a lack of suitable connecting habitat remaining in B.C. (COSEWIC 2006).

Needs of the Pacific Water Shrew

Habitat and biological needs

Suitable habitat

The Pacific Water Shrew is considered to be a riparian specialist and is captured in streamside riparian zones, marshes, wetlands, and dense wet forests (COSEWIC 2006). Capture sites in B.C. appear to be primarily associated with streams or wetlands in coniferous (western redcedar – western hemlock) or deciduous forest; they have also been captured in more open habitat, with dense marsh/wetland vegetation (Ministry of Environment, unpubl. data). Gomez (1992) found that upslope (350 m off streamside transects) captures of Pacific Water Shrew in western Oregon were associated with intermittent watercourses. Recently in B.C., some Pacific Water Shrews have been captured along channelized watercourses (ditches; Ministry of Environment, unpubl. data). In Oregon, Pacific Water Shrews primarily associate with skunk cabbage marshes and small streams in riparian alder habitat (Maser et al. 1981).

In a review of studies, primarily from the United States, Galindo-Leal and Runciman (1994) reported that the majority of water shrews were captured within 25 m of streams. In a study in southern Washington, Stinson et al. (1997) reported all Pacific Water Shrews ($n = 26$) were captured on grids placed ≤ 50 m from water; none were captured on grids placed 100 or 130 m from water.

Downed wood appears to be an important habitat component for this species, as it is for terrestrial shrews and other small mammal species. The one known nest of a Pacific Water

Shrew was built under bark of a log (Maser et al. 1981), and Pacific Water Shrews are often successfully captured under logs (Ingles 1965; D. Knopp pers. Comm., 2007). Large logs that overhang the ground provide ideal travel corridors for shrews and other small mammals (Hayes and Cross 1987; Craig 1995) and increase the continuity of cover (Terry 1981). Decayed logs also serve as foraging habitat for shrews; as logs decay they provide habitat for different communities of invertebrates (Maser and Trappe 1984; Harmon et al. 1986). Terrestrial shrews will forage in the open and then use logs to cache or consume prey in safety (McLeod 1966; Yoshino and Abe 1984); it is likely that logs are used similarly by Pacific Water Shrews.

Based on the limited data, Pacific Water Shrews will use all forest structural stages except clear-cuts (Corn and Bury 1991; Lomolino and Perault 2001; COSEWIC 2006; Ministry of Environment unpubl. data); however, the capture data suggest that Pacific Water Shrews are more abundant in older forests than younger forests (COSEWIC 2006).

Home Range/Movement

Home ranges are likely long, narrow bands that follow the water's edge, similar to those described for other aquatic shrews, such as the European Water Shrew (*Neomys fodiens*; Churchfield 1990). Harris (1984) estimated that Pacific Water Shrews have home ranges 1.09 ha in size, although there is some uncertainty in the source of this estimation. It is unknown whether Pacific Water Shrews are territorial.

The dispersal abilities of the Pacific Water Shrew are unknown. Pattie (1973) reported that Pacific Water Shrews were found up to 1 km from water in moist forests, McComb et al. (1993) captured Pacific Water Shrews up to 350 m from permanent water, and Maser et al. (1981) suggested that young disperse during winter into wet forested habitat. Additional research is required to determine if Pacific Water Shrews captured far from water are dispersing individuals, residents, or if they are associated with nonpermanent watercourses. Although Pacific Water Shrews appear able to move through moist forest, their ability to travel across fragmented, non-forested, or dry forest habitat is poorly known. Using a precautionary approach we assume that resident Pacific Water Shrews will typically occupy habitat up to 60 m from a watercourse.

No research has been conducted on the length of stream required to maintain a population of Pacific Water Shrews. Thomas (1979) estimated a viable population of the American Water Shrew (*S. palustris*), which has similar life history characteristics to the Pacific Water Shrew, might require a minimum of 1600 m of linear stream habitat.

Foraging

The bite force of the Pacific Water Shrew is relatively low, meaning that it likely has a relatively soft diet (Carraway and Verts 1994). This assumption is supported by the data from Pattie (1969) who reported that captive Pacific Water Shrews would not eat beetles and crayfish when offered, but ate softer-bodied food items such as earthworms, sowbugs, termites, centipedes, and spiders. Pacific Water Shrews also consume aquatic arthropods (Pattie 1969). Whitaker and Maser (1976) reported that aquatic invertebrates comprised 25% of the stomach contents of Pacific Water Shrew. Stomach contents included insect larvae, slugs, snails, ground beetles, harvestmen, and earthworms.

Pacific Water Shrews forage under water for up to 3.5 minutes (Pattie 1969). Captive Pacific Water Shrews cached items and consumed all prey items on land (Pattie 1969). Because of their high metabolism, restricted habitat preference, and specialized diet, Pacific Water Shrews may be more heavily influenced by changes in their habitat than larger species that are able to move relatively long distances and take advantage of a variety of habitats and food sources (Teferi and Millar 1993).

The eyesight of Pacific Water Shrew is poor, similar to other shrew species (Pattie 1973). Like other shrew species, Pacific Water Shrews are likely capable only of light/dark discrimination (Branis and Burda 1994). Shrews of the genus *Sorex* may have a crude form of echolocation (Buchler 1976; Branis and Burda 1994) that is too insensitive to use while foraging, but may be used while exploring terrestrial habitats (Nagorsen 1996). Pacific Water Shrews use their snout to pry under objects underwater, and use their whiskers to sense the presence of food (Nagorsen 1996). Pacific Water Shrews appear to be primarily crepuscular and nocturnal, but they are occasionally trapped during the day.

Breeding

No studies have been conducted in B.C., but data from Oregon suggest that the breeding season extends from January to August (Maser et al. 1981). Pregnant females have been found in April and May (COSEWIC 2006), and sexually reproductive females captured May through July (Maser et al. 1981). Nestlings have been discovered in March (Pattie 1969; COSEWIC 2006). The litter size has been reported as 3-4 (Pattie 1969) to 5-7 (in Oregon, Verts and Carraway 1998); females likely bear 2 to 3 litters per year (COSEWIC 2006). One Pacific Water Shrew nest, made from shredded bark, has been discovered under loose bark of a Douglas-fir tree (Maser et al. 1981). Pacific Water Shrews likely live approximately 18 months (COSEWIC 2006). Male Pacific Water Shrews do not breed their first summer (Nagorsen 1996).

Based on the data available, the best quality habitat for the species is currently defined as:

A permanent stream or wetland (including swamps, marshes, etc.) with an intact 100-m riparian area around each side of the watercourse. The riparian area consists of a mature or maturing coniferous forest (structural stages 5-7) of western redcedar and/or western hemlock or deciduous forest (structural stages 4-7) and at least 1.5 km of linear stream habitat.

Other suitable and/or important habitats are:

- Sites similar to those described above, but at younger structural stages
- Non-forested natural sites around streams/wetlands with heavy shrub cover
- Ephemeral or intermittent waterways
- Corridors (preferably riparian habitat, but potentially moist mature coniferous or deciduous forest) connecting habitat
- Habitat surrounding the watercourse or wetland sufficient to protect the normal functioning of the riparian ecosystem
- Site indicators of rich habitat such as skunk cabbage (*Lysichiton americanus*) or devil's club (*Oplopanax horridus*) may indicate suitable habitat
- Downed wood is also a valuable habitat component.

Given the elusive nature of the species, no studies have been conducted on the demography of Pacific Water Shrew relative to habitat, which is necessary to fully evaluate what constitutes the "best" habitat for the species (i.e., higher survival rates, growth rates, reproductive rates associated with healthy populations in best habitat; Van Horne 1983).

Ecological role

Pacific Water Shrew is a predator of terrestrial and aquatic invertebrates and is an obligate species of riparian ecosystems. Although Pacific Water Shrew is likely prey to owls, weasels, and Coastal Giant Salamanders (*Dicamptodon tenebrosus*), shrews are not a preferred food source for most species.

Limiting factors

The following factors likely limit the distribution and potential recovery of Pacific Water Shrew:

- **Habitat specificity:** Pacific Water Shrews require riparian and wetland habitat at low elevations. This habitat specificity may increase the potential impacts of habitat loss and habitat fragmentation on the species by limiting the ability of Pacific Water Shrews to move among habitat fragments. As a result, many created features may be perceived as barriers (e.g., potentially roads, culverts, agricultural fields).
- **Restricted distribution (historical):** the Pacific Water Shrew in Canada is at the northern limit of its distribution. It occurs in a restricted area in the southwest corner of British Columbia, which is an area of rapid population growth and development and habitat change (COSEWIC 2006). The reason behind the species' restricted distribution is unknown, but likely is at least partially due to competition with the American Water Shrew (COSEWIC 2006).

Threats

Threat classification

Table 1. Threat classification table for Pacific Water Shrew.

1		Urban development		Threat attributes		
Threat category	Habitat loss or degradation	Extent	Widespread			
			Local	Range-wide		
General threat	Urban development including housing development, road construction, and golf courses	Occurrence	Current			
		Frequency	Continuous			
Specific threat	Removal of riparian habitat, destruction of stream, creek, or wetland habitat; encroachment into riparian areas; modification of in-stream environment (higher water temperature, removal of habitat, loss of aquatic prey base); siltation; water crossings requiring artificial substrate; culverts that may be barriers to shrew movement; road runoff negatively affecting aquatic prey; improperly maintained septic systems polluting waterways that would affect aquatic prey; improper stormwater management; creation of channelized habitat; fragmentation of habitat	Causal certainty	High			
		Severity	High			
Stress	Increased mortality, reduced resource availability, population isolation, reduction of food resource	Level of concern	High			
2		Forestry		Threat attributes		
Threat category	Habitat loss or degradation	Extent	Widespread where forested land occurs			
			Local	Range-wide		
General threat	Forestry practices close to riparian habitat	Occurrence	Current			
		Frequency	Continuous			
Specific threat	Removal or degradation of riparian habitat; loss of creek, stream, or wetland; modification of in-stream environment (higher water temperature, removal of habitat, loss of aquatic prey base), streambank instability, siltation, fragmentation of habitat	Causal certainty	High	High		
		Severity	High	High		
Stress	Increased mortality, reduced resource availability, population isolation, reduction of food resource	Level of concern	High			
3		Agriculture		Threat attributes		
Threat category	Habitat loss or degradation	Extent	Widespread where agricultural lands occur			
			Local	Range-wide		
General threat	Agricultural practices close to riparian areas	Occurrence	Current			
		Frequency	Continuous			
Specific threat	Removal of riparian habitat; modification of in-stream environment (higher water temperature,	Causal certainty	High	High		

	removal of habitat, loss of aquatic prey base); siltation; trampling of riparian habitat by livestock; runoff of fertilizer or pesticides into waterways affecting aquatic prey base; fragmentation of habitat	Severity	High	High
Stress	Increased mortality, reduced resource availability, population isolation, reduction of food resource	Level of concern	High	
4 Pollution		Threat attributes		
Threat category	Pollution	Extent	Unknown, potentially widespread	
			Local	Range-wide
General threat	Housing development, roads, use of fertilizers and pesticides in agriculture, use of pesticides in forestry	Occurrence	Current	
		Frequency	Unknown	
Specific threat	Runoff from roads (salt, oil, sand) that may affect aquatic prey base, siltation, pesticide runoff, oil in water may adversely affect insulating effect of shrew pelage	Causal certainty	Medium	
		Severity	Unknown	
Stress	Reduction of food resource, increased mortality	Level of concern	Medium	
5 Predation – domestic pets		Threat attributes		
Threat category	Predation	Extent	Localized across the range	
			Local	Range-wide
General threat	Domestic cats – feral and domesticated	Occurrence	Current	
		Frequency	Unknown	
Specific threat	Predation by domestic cats, threat highest in urban and agricultural areas	Causal certainty	Low	
		Severity	Unknown	
Stress	Increased mortality	Level of concern	Low to Medium	
6 Trapping mortality		Threat attributes		
Threat category	Accidental mortality	Extent	Localized across the range	
			Local	Range-wide
General threat	Trapping	Occurrence	Unknown	
		Frequency	Recurrent	
Specific threat	Bycatch in minnow traps or during small mammal trapping programs	Causal certainty	Low	
		Severity	Unknown, potentially locally High	
Stress	Increased mortality	Level of concern	Low to Medium	
7 Climate and natural disasters		Threat attributes		
Threat category	Climate and natural disasters	Extent	Localized across the range	
			Local	Range-wide

General threat	Flooding, improper stormwater management	Occurrence	Current
		Frequency	Unknown
Specific threat	Sudden flooding of watercourses resulting in animals drowning, channelization of watercourses, siltation and loss of habitat	Causal certainty	Low
		Severity	Low
Stress	Increased mortality, reduction of food resource, reduced resource availability	Level of concern	Low

Description of the threats¹

Threat 1 – urban development

Urban development, including housing development, road construction and golf courses causing loss and degradation of riparian habitat is likely the greatest threat to survival and recovery of Pacific Water Shrew (COSEWIC 2006). Urban development is chronic and widespread across the entire range of the Pacific Water Shrew. The threat is most severe in the western section of its range (e.g., Point Grey area of Vancouver), and is becoming more of a threat in the south-central portion of its range (Surrey and surrounding area). Development activities often involve the removal of all or some riparian habitat, resulting in changes in watercourse conditions that might influence shrews directly (e.g., increased predation in areas with reduced cover) or indirectly (e.g., increased water temperature due to removal of riparian vegetation that adversely affects the aquatic prey base of the shrew). The removal of overstorey trees results in changes in microclimate (Chen et al. 1993), as well as changes in input of organic material to aquatic habitat. These changes in turn affect characteristics of water quality (temperature, pH, turbidity, etc.), increase stream susceptibility to runoff from pesticides, fertilizers, herbicides, or other sources of pollution, increase stream flow, and can alter the stability of the stream channel (Kelsey and West 1998). Encroachment of human property and activity into riparian areas adjacent to urban development (e.g., treating the adjacent riparian habitat as an extension of the property) is an additional potential source of habitat degradation. Loss or degradation of habitat suitable for Pacific Water Shrew, and placement of roads and railways on the landscape also causes fragmentation of habitat, which likely limits the ability of Pacific Water Shrews to disperse between fragments. Habitat fragmentation is an increasing threat to the survival and recovery of Pacific Water Shrew throughout its range. Current retention regulations aimed at protecting fish habitat specify riparian buffers as small as 5 m under some conditions (*Fish Protection Act*, which is part of the Streamside Protection Regulation), which is inadequate to protect Pacific Water Shrew habitat.

Threat 2 – forestry

Forestry practices near riparian habitat may result in the removal of riparian habitat, causing the loss or degradation of habitat for Pacific Water Shrew as described above under urban development. Removal of the forest canopy around riparian areas also results in at least temporary habitat fragmentation unless the riparian corridor is preserved. In addition, runoff or drift of fertilizers or herbicides used in forestry practices may adversely affect aquatic

¹ Please be advised that these are the threats known at this time but additional threats may come forward as more research is conducted.

invertebrate prey of Pacific Water Shrew. Forestry is a widespread threat within the range of the Pacific Water Shrew, and is a major threat to areas of relatively undisturbed habitat.

Threat 3 – agriculture

Agricultural practices may result in the degradation (primarily; some habitat may also be lost if new areas are converted to intensive agriculture) of Pacific Water Shrew habitat as described above under urban development. In addition, pollution of the aquatic environment from runoff or drift of fertilizer, herbicides, or pesticides used on agricultural land may adversely affect aquatic invertebrate prey of Pacific Water Shrew. Access of livestock to riparian areas can result in trampling of riparian vegetation or degradation of the instream environment (streambank erosion, siltation).

Threat 4 – pollution

Pollution of the aquatic system has the potential to negatively affect aquatic invertebrates, which are an important prey of Pacific Water Shrew. In addition, contaminants such as oil might reduce the insular properties of the fur of Pacific Water Shrew (COSEWIC 2006). Main sources of pollution would be runoff from roads (salt, sand, oil), and runoff or drift of fertilizers, herbicides, or pesticides applied to urban, forestry, or agricultural lands.

Threat 5 – predation – domestic pets

Galindo-Leal and Runciman (1994) identified mortality from domestic cats as a potentially important threat to Pacific Water Shrew in urban and agricultural areas. The rate of mortality from cats, and the overall effect of domestic cats on populations of Pacific Water Shrew, is unknown. Predation by domestic cats could be an important source of mortality in localized areas, potentially associated with specific individual cats that prey on shrews.

Threat 6 – trapping mortality

Pacific Water Shrews are sometimes accidentally captured in minnow traps set during fisheries surveys, as well as in traps set to capture small mammals during research projects. It is likely that Pacific Water Shrews occur at naturally low densities (COSEWIC 2006); therefore, mortality from these sources might result in a locally high mortality rate, particularly where multiple individuals are captured. The level of overall threat to Pacific Water Shrews from accidental trapping mortality is unknown.

Threat 7 – climate and natural disasters

Sudden flooding, especially along streams and creeks, has the potential to adversely affect Pacific Water Shrews directly (drowning) and indirectly (channelization, scouring of streambanks causing loss of burrows and riparian vegetation, streambank instability contributing to siltation that could adversely affect aquatic invertebrates). Improper stormwater management associated with housing developments might contribute to local flooding.

Actions Already Completed or Underway

The following actions have been completed or are currently underway:

- A best management practices (BMP) document (Craig and Vennesland 2007) is available that provides guidelines for when and how environmental assessments for Pacific Water Shrew should be carried out. The document also includes suggestions for habitat protection where suitable habitat or a Pacific Water Shrew is found. This document has been widely used in areas scheduled for development (primarily housing developments or road construction), and has resulted in recommendations for habitat protection in numerous areas in the lower mainland.
- Extension documents have increased the profile of Pacific Water Shrew among fisheries and environmental assessment consultants.
- Habitat suitability/capability models have been created for Pacific Water Shrew (Craig 2006, 2007). Draft models use Terrestrial Ecosystem Mapping (TEM) data and Sensitive Habitat Inventory Mapping (SHIM) data to classify habitat capability (TEM) and suitability (TEM and SHIM) as high, moderate, low, or nil. The BMPs for the species use the TEM model to assist in environmental assessments. The current models should be regularly updated to incorporate the latest available information on habitat associations.
- Three areas around known Pacific Water Shrew locations have been approved for protection within Wildlife Habitat Areas (WHAs, see Appendix A). As suitable additional sites for protection are discovered on provincial Crown land, additional areas will be proposed for protection in WHAs.
- An action plan is being drafted by the recovery team.
- A draft partial definition of survival and recovery habitat for Pacific Water Shrew is in review by the recovery team.

Knowledge Gaps

Knowledge of the ecology and distribution of Pacific Water Shrew in Canada is limited. General information about habitat trends in British Columbia is sufficient to identify several potential threats to the species, but inadequate to identify the extent of certain threats, promote detailed plans for recovery, or fully assess recovery progress. Important knowledge gaps include:

- Current species distribution: the current range of the species as well as presence/absence information within areas of the range is not fully delineated. This information is beneficial to refine specific recovery actions (such as habitat rehabilitation, or promoting connectedness between habitat patches), as well as to assess recovery efforts. This knowledge gap is the highest priority for increased knowledge.
- Habitat requirements and barriers to movement: this information is beneficial to hone the definition of highest quality habitat for Pacific Water Shrews and to refine critical habitat, as well as to ensure that habitat restoration projects include habitat components most valuable for shrews. Research on understanding barriers to movement (e.g., are culverts or open agricultural fields barriers to movement?), and research on the suitability of channelized watercourses to Pacific Water Shrew is necessary to assess current habitat suitability and to promote connectedness between habitat fragments.
- Dispersal abilities and necessary attributes of corridors for Pacific Water Shrew: the ability of Pacific Water Shrew to disperse to adjacent habitats may be contingent on the presence of certain habitat attributes or the corridor being the correct size. The ability to create suitable

corridors for movement of Pacific Water Shrew will be improved by our understanding these requirements.

- Minimum size of habitat areas: the minimum size of habitat areas required to protect a self-sustaining population of Pacific Water Shrew.

RECOVERY

Recovery Feasibility

Recovery of the Pacific Water Shrew is biologically and technically feasible. Captures of Pacific Water Shrew over time indicate that reproductive individuals are available and capable of reproduction. The primary threats to Pacific Water Shrew populations are habitat loss, habitat degradation, and habitat fragmentation. These threats can be mitigated through habitat protection, management, and rehabilitation. Limited information on habitat associations of Pacific Water Shrew is available; additional research is required to ensure that sufficient suitable habitat currently exists or can be created to sustain the population in the long-term. Recovery techniques consist of threat mitigation, which is deemed to be the most effective approach to recovery of this species.

Recovery Goal

The overall goal for recovery of the Pacific Water Shrew in B.C. is:

To halt the decline of Pacific Water Shrew and ensure a self-sustaining population within secure habitat throughout its current and historical range in Canada, where habitat still exists or can be restored (achieved within 10 years).

This long-term goal can be achieved by ensuring effective protection of known populations, conserving and restoring habitat connectivity, and increasing knowledge of habitat requirements and occurrences.

This goal is best addressed in two distinct parts:

Goal A: ensure that the current B.C. population of Pacific Water Shrew is maintained with no further loss of local populations (achieve within 5 years).

Goal B: restore Pacific Water Shrew back to its historical range, where suitable and/or connecting habitat still exists, or can be rehabilitated, so that patterns of natural population dynamics and dispersal can be maintained or restored (achieve within 10 years).

Rationale for the Recovery Goal

The historical range of Pacific Water Shrew in Canada has likely always been restricted to riparian areas of the Lower Mainland of British Columbia. The estimated extent of occurrence of the Pacific Water Shrew, which includes all historical and recent occurrences (but not sightings), is approximately 5700 km²; its current area of occupancy is unknown (COSEWIC 2006).

Riparian habitat in the area will remain under continued threat from urbanization, agriculture, forestry, and industrial activities and their byproducts such as road building, improperly maintained septic fields, inadequate storm water drainage planning, and runoff. There is a high probability that maintenance of the species will require continued habitat management, and as such may never be considered "secure" in Canada.

Recovery Objectives

Specific recovery objectives are:

1. Protect all known extant sites by addressing threats, and protecting/restoring/managing Pacific Water Shrew habitat to prevent further habitat degradation/loss and population declines (habitat protection and management - within 2 years).
2. Restore historical and important potential habitats to rehabilitate/retain recovery sites for Pacific Water Shrew (habitat restoration - within 10 years).
3. Prevent habitat fragmentation and ensure habitat connectivity by identifying, maintaining, or restoring a connected network of dispersal habitat to facilitate meta-population dynamics within the known historical range of Pacific Water Shrew (habitat connectivity, modeling, mapping and restoration- within 10 years).
4. Prevent the inadvertent loss of not-yet discovered populations by conducting a comprehensive inventory of potentially suitable Pacific Water Shrew habitat (surveys); maintaining current habitat models and maps (modeling and mapping); and ensuring the occurrence data, essential habitat data, and management tools are readily assessable (information management and outreach/education - within 5 years).
5. Address immediate threats such as mortality from introduced predators and incidental captures (mitigate direct mortality - within 5 years).
6. Evaluate implemented protective measures and recovery activities to ensure that they are effective in maintaining known populations and suitable habitat (monitoring and evaluation - within 5 years).
7. Increase our understanding of the critical habitat needs, life history, population dynamics, and habitat use of the species, and clarify threats facing these populations, so that appropriate conservation measures can be taken (research - within 10 years).

Approaches Recommended to Meet Recovery Objectives

Recovery planning table

Table 2. Recovery planning table for Pacific Water Shrew (PWS).

Priority	Obj. No.	Threats addressed	Broad strategy to address threat	Recommended approaches to meet recovery objectives
Urgent	1	Urban development, forestry, agriculture, climate and natural disasters	Habitat protection and management	<ul style="list-style-type: none"> • Establish protection on Crown land (e.g., WHAs on forest land). • Finalize survival and recovery habitat spatial definition/mapping and consultation and provide results to relevant agencies and land users. • Update, distribute, and promote the use of best management practices (BMPs). • Coordinate with land owners (voluntary), stewardship groups, and land trust and conservancy organizations to protect habitat through covenants or stewardship agreements. • Ensure development projects under the Canadian <i>Environmental Assessment Act</i>, Riparian Area Regulation, or other relevant legislation/policies avoid and/or mitigate impacts to Pacific Water Shrew. • Where PWS occurrences are identified on federal land, partner with federal agencies to implement habitat protection. • Where possible acquire land at high risk sites or important habitat (typically around multiple occurrences) for conservation. • Enforce current regulations around riparian areas. • Work with MOFR, MSRM, MOE, DFO and stewardship organizations to ensure that regulations/covenants are enforced. • Conduct a regulatory gap analysis to press for improved regulatory/legislated tools.
Urgent	2, 3	Urban development, forestry, agriculture	Restore habitat and connectivity	<ul style="list-style-type: none"> • Develop guidelines for habitat rehabilitation and distribute to funding bodies and agencies (e.g., DFO, Habitat Conservation Trust Fund) for implementation to avoid conflict with fisheries compensation activities and works. • Identify candidate areas for habitat rehabilitation – work with municipalities and stewardship groups, and incorporate information from habitat capability/suitability maps. • Rehabilitate/manage habitat to ensure that it becomes/remains suitable for PWS. • Coordinate with stewardship groups to incorporate habitat for PWS into rehabilitation projects. • Where necessary, work with landowners to fence riparian areas to prevent disturbance by people, pets, or livestock. • Coordinate with regional districts, municipalities, and forest licensees to promote connectedness among riparian habitat through landscape-level planning. • Identify priority areas for protection, management, and rehabilitation to promote habitat connectedness throughout range.
Urgent	4, 6	All	Surveys, monitoring and evaluation	<ul style="list-style-type: none"> • Conduct surveys to further determine range of PWS and presence/absence. • Conduct surveys to determine status and condition of habitat within range of PWS, particularly at all known local populations, to assess recovery efforts.

Priority	Obj. No.	Threats addressed	Broad strategy to address threat	Recommended approaches to meet recovery objectives
Urgent	4	Habitat loss, habitat degradation, habitat fragmentation, pollution	Modeling/ mapping, information management	<ul style="list-style-type: none"> • Evaluate the effectiveness of implemented mitigation measures – e.g., WHA buffers. • Maintain a current database and map delineating survival and recovery habitat – make available as a SHAPE file to prevent inadvertent impacts to populations. • Update and refine habitat capability/suitability model based on research/surveys. • Use habitat models to guide environmental assessments (BMPs), and to identify priority areas for protection and rehabilitation. • Incorporate information on land use and landscape features to identify potential barriers to PWS movement, as well as potential areas of degraded habitat.
Urgent	5	Direct mortality – predation by domestic pets and trapping mortality	Mitigate direct mortality	<ul style="list-style-type: none"> • Develop a non-invasive trapping methodology to be employed during fisheries assessments – to reduce inadvertent drowning of PWS in g-traps /minnow traps. • Target landowners within occupied areas to keep cats indoors – may include a feral cat sterilization program.
Necessary	All	All	Education/ outreach	<ul style="list-style-type: none"> • Improve communication among stakeholders (e.g. municipalities, consultants, industry, government and others), and inform the public about PWS and issues surrounding their recovery. • Educate and increase capacity of municipalities/consultants to assess and manage Pacific Water Shrews. • Educate and change behaviors of fisheries researchers/consultants on issue of PWS mortality in minnow traps. • Educate public re: the issue of mortality by domestic cats and other introduced predators. • Educate public and developers re: PWS and issues such as encroachment on riparian areas, and pollution of waterways. • Educate agriculture landowners about issues such as runoff of pesticides and fertilizers into watercourses as well as damage by livestock. • Coordinate with stewardship groups to provide education and outreach, and to protect or manage habitat. • Coordinate with GVRD in its Biodiversity Strategy to promote connectedness across range.
Necessary	1, 2, 3, 5, 6, 7	All	Research	<ul style="list-style-type: none"> • Conduct research on an efficient method of surveying PWS, and trapping methods to reduce trap mortality. • Conduct research on PWS populations to refine definitions of important habitat and critical habitat attributes. • Identify quantitative measures of PWS populations and habitat to assess recovery efforts, once population has been surveyed. • Investigate usefulness of channelized (ditch) habitat to PWS. • Conduct research on what constitutes a barrier to movement of PWS (potential: culverts, agricultural fields, roads, urban habitat). • Conduct research on attributes of corridors preferred by PWS. • Conduct research to clarify threats to PWS and PWS habitat. • Conduct research on the size and effectiveness of buffer strips required to protect habitat suitable for PWS. This includes assessing and monitoring the effectiveness of implemented buffers in WHAs

Priority	Obj. No.	Threats addressed	Broad strategy to address threat	Recommended approaches to meet recovery objectives
Necessary	All	All	Funding applications	<p>(30 m core, 45 m management zone) as they differ from the recovery team's recommended buffer of 100 m.</p> <ul style="list-style-type: none"> • Apply for funding to purchase land. • Apply for research funding. • Apply for funding to support rehabilitation projects, potentially in partnership with fisheries stewardship organizations.

Narrative to support recovery planning table

To successfully reach recovery objectives for the Pacific Water Shrew there will be a strong need to engage in stewardship on a variety of land tenures. Stewardship involves the voluntary cooperation of landowners to protect species at risk and the ecosystems they rely on. Because the Pacific Water Shrew occurs predominantly on private lands, stewardship efforts will be the key to their conservation and recovery. This will require voluntary initiatives by landowners to help maintain areas of natural ecosystems that support this species. This stewardship approach will cover many different kinds of activities, such as following guidelines or best management practices for Pacific Water Shrew; voluntarily protecting important areas of habitat on private property; placing conservation covenants on property titles; and eco-gifting or selling property (in whole or in part) for conservation.

Performance Measures

Detailed quantitative performance measures will be developed based on the review of survival and recovery habitat within the action plan.

Table 3. Performance measures for Pacific Water Shrew.

Broad Strategy	Obj. No.	Performance Measures
Habitat protection and management	1	<ul style="list-style-type: none"> • WHAs proposed and implemented on all occupied forested Crown land. • Best management practices (BMPs) were updated and implemented by consultants and local governments and during development projects. Environmental assessments and consultants with Wildlife Act permits use proper trapping methodology and avoidance /mitigation measures - to be evaluated every 5 years. • Private land owners, stewardship groups, and land trust and conservancy organizations engaged and acting to protect habitat through covenants or stewardship agreements. • Federal agencies implemented habitat protection on federal lands – e.g., Department of National Defence (DND). • Established contacts with DFO, MSRM, and MOFR to discuss enforcement of current regulations. Target: at least 1 meeting (electronic/telephone or in person) per year. • Established contacts with municipalities to discuss enforcement of current regulations, and issues of encroachment. Target: at least 1 meeting (electronic/telephone or in person) per year. • Established contacts with stewardship groups and land trust organizations to identify and enforce existing covenants on riparian habitat. Target: at least 1 meeting (electronic/telephone or in person) per year. • Number of actions taken to enforce current regulations on riparian habitat, and their outcome.
Restore habitat and connectivity	2, 3	<ul style="list-style-type: none"> • Habitat rehabilitation guidelines developed and distributed to funding bodies and agencies. Restoration activities improve habitat for PWS as well as fish. Assessed through Water Act permits and review of fisheries rehabilitation projects - to be evaluated every 5 years. • Candidate areas for habitat rehabilitation identified. At least 2 projects to increase habitat suitability for PWS have funding secured and underway at historical or key sites within 5 years. • A commitment to restore/maintain connectedness through landscape-level planning by regional districts, municipalities, or forest licensees. Number of habitat fragments connected. Target: connect at least 2 pairs of habitat fragments within 10 years.
Surveys/monitoring	4, all	<ul style="list-style-type: none"> • Development of a non-invasive efficient method of surveying for Pacific Water Shrew. • Amount of range surveyed for Pacific Water Shrew (percentage of estimated range, number of sampling locations). • Current range of PWS as a percentage of historical range. • Occupied sites monitored regularly to detect changes in presence/absence or habitat/population characteristics.

Modeling/mapping and information management	4	<ul style="list-style-type: none"> • Updated habitat suitability/capability model within 2 years and whenever there are new detections. • Ground-truth and refine model to improve predictive ability. Target: ground-truth the model at a minimum of 10 locations within 5 years. • Using habitat identified by model as high, moderate, low, or nil, survey the habitat and for PWS to assess presence/absence and refine model as necessary (percentage of sites surveyed where the model provided an appropriate rating). • Current database and habitat mapping was available to help protect and manage PWS survival and recovery habitat.
Mitigate direct mortality	5	<ul style="list-style-type: none"> • Non-invasive and efficient traps developed and made available for use. • Decrease in the number of reported PWS mortalities and increase in live captures during environmental and fisheries assessments.
Education/outreach	5	<ul style="list-style-type: none"> • Number of research projects conducted. • Increase in knowledge about habitat associations of Pacific Water Shrew, or habitat elements required by Pacific Water Shrew. • Ability to add to or remove potential threats to Pacific Water Shrew (specifically the importance of pollution and domestic cats as threats to populations of Pacific Water Shrew). • Conducted research on the effectiveness of implemented management zones to ensure that recommended management zones are effective in ensuring the long-term persistence of the species and to obtain additional science-based data to inform future recommendations. This includes evaluating the effectiveness of implemented management zones in WHAs.
Funding applications	All	<ul style="list-style-type: none"> • Amount of funding acquired, subtotaled by topic (research, habitat protection, habitat rehabilitation, outreach etc.). • Number of funding applications submitted. Target: at least 1 funding application/year. • Percentage of funding applications that were successful.

Critical Habitat

Identification of the species' critical habitat

"Critical habitat" is defined under the federal *Species at Risk Act* (SARA) as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." Critical habitat under the federal *Species at Risk Act* is not proposed for identification in this document. Additional detailed mapping and consultation with landowners and land managers will be required before critical habitat can be formally proposed. Habitat required for the recovery of the species will be identified through the schedule of studies needed to identify critical habitat (below), and will be included in the forthcoming action plan. Many of the potential areas of critical habitat include private land, and consultation with landowners is required before the areas are finalized.

For Pacific Water Shrew, habitat necessary for survival is based on known occurrences, and habitat necessary for recovery is related to historical and high-suitability sites needed to maintain a self-sustaining viable population. Based on the biological and habitat needs of the species (see habitat and biological needs section), the area required for survival should include a 100-m protective area around each side of the watercourse / water bodies associated with capture

location (where habitat is available) and a stream segment at least 1.5 km long. This definition is subject to change as additional data are collected.

Recommended schedule of studies to identify critical habitat

Table 4. Schedule of studies.

Description of activity	Outcome/rationale	Timeline
Surveys to determine the distribution of species	Development of a more efficient method of assessing presence/absence. Refine the distribution of the species, identifying additional areas of presence/absence. Permits refinement and identification of additional survival/recovery habitat, and potential connecting habitat.	2009-2012
Identify quantitative population and habitat targets (e.g., distribution of populations and/or habitat, density of Pacific Water Shrews, population characteristics)	Development of quantitative population and habitat targets is beneficial to guide identification of critical habitat to ensure that habitat is protected across the range of the species.	2010-2012
Research on habitat associations	Increased knowledge will be beneficial to refine the essential habitat attributes and features for the species (based on population indicators). Research should provide feedback to the habitat suitability/capability models, and also include habitats such as channelized watercourses to assess their usefulness to shrews. Assist in refining critical habitat areas.	2009-2015
Refine habitat capability/ suitability models	Ground-truth current habitat capability/suitability models and use research outcomes to refine the model. Model will assist in identifying additional critical habitat.	2009-2012

Existing and Recommended Approaches to Habitat Protection

The amount of habitat legally protected for Pacific Water Shrew is unknown (COSEWIC 2006). Currently there are 5 provincial and 26 regional parks within the range of Pacific Water Shrew, although little suitable habitat is protected inside their boundaries (COSEWIC 2006). In addition, there are 4 areas of federal land (Department of National Defence; 1437 ha) and 62 Indian Reserve lands (8553 ha; COSEWIC 2006) within the range of the species. Suitable habitat for Pacific Water Shrew has been identified on 2 areas of federal land (Department of National Defence); the suitability of the other 2 areas and the additional 62 Indian Reserve lands has not been assessed. Approximately 20% of the range of the Pacific Water Shrew is Crown land, but most of the suitable Pacific Water Shrew habitat is on private land (COSEWIC 2006). Three areas of Crown land (totaling 21.7 ha core and 23.6 ha Management Zone, see Appendix A) where Pacific Water Shrews have been captured are under the protection and management of Wildlife Habitat Areas (see Appendix A).

Currently, some habitat protection is in place for riparian habitat on forested Crown land under the 1995 *Forest Practices Code Act* and the 2003 *Forest and Range Practices Act*. The degree of protection is dependent on whether the stream is in a community watershed, is a fish-bearing stream, and the size of the stream (Table 2, *Forest Practices Code Act* of B.C. 1995). Wetlands have varying degrees of protection, depending on their size, location, and landscape considerations. Pacific Water Shrews have been captured along small and non-fish-bearing streams and small wetlands, which would receive limited to no protection under the Riparian

Management Regulations. Regulations guiding activities around riparian areas exist (Riparian Areas Regulation of the *B.C. Fish Protection Act*, *Forest and Range Practices Act*), but in many cases require only small buffers or no buffers (in cases of small, non-fish-bearing streams or wetlands) and so are inadequate to protect shrew habitat. The document *Best Management Practices Guidelines for Pacific Water Shrew in Urban and Rural Areas* (Craig and Vennesland 2007) provides guidelines for protecting Pacific Water Shrew habitat, including a recommended 100-m protective area around known Pacific Water Shrew occurrences or around good-quality habitat. The *Species at Risk Act* (SARA) Section 137 amended the *Canadian Environmental Assessment Act* (CEAA) to include impacts on species at risk in three ways: (1.) amended the definition of “environmental effect” to include impacts to species at risk; (2.) required notification of potential impacts to responsible authorities - Section 79(1); and (3.) included mitigation and monitoring requirements - Section 79(2). CEAA and the B.C. *Environmental Assessment Act* are harmonized.

The Pacific water shrew recovery team recommends establishing habitat protection based on known recent (<20 years) confirmed occurrences where protection is not currently in place. The recovery team identified 19 areas encompassing 24 locations as recent confirmed occurrences. Additional areas will need to be identified to meet the recovery goal for the species. Priority areas for protection would include areas around recent captures, such as the 19 potential priority areas under review by the Pacific Water Shrew Recovery Team (Pacific Water Shrew Recovery Team 2007); areas of contiguous and/or undisturbed habitat; areas with numerous Pacific Water Shrew records; areas under severe immediate threat; or areas necessary to preserve habitat corridors between fragments; and areas with historical records where the habitat still exists or can be restored.

Effects on Other Species

Recovery actions for Pacific Water Shrew are unlikely to have any negative effects on non-target species or communities within its range. The proposed actions emphasize habitat protection, restoration, and connection with natural communities and processes, and restoring the proper functioning of riparian ecosystems, all of which will benefit other native species including several commercial fish species.

Socioeconomic Considerations

Although the Pacific Water Shrew Recovery Team members reached consensus that recovery is a valuable undertaking, they recognize and appreciate that recovery will bring challenges as the benefits and costs of recovery are balanced with the benefits and costs from commercial utilization of aspects of the habitat of Pacific Water Shrew. The primary challenge is finding a solution that will balance conservation and species recovery (generally considered positive effects) with potential necessary reductions in resource utilization, and increased management and research costs (negative effects).

The recovery team identifies several positive socioeconomic benefits of Pacific Water Shrew recovery related to (1.) biodiversity and sustainable resource management, (2.) species at risk

legal obligations and jurisdictional independence, (3.) international trade and cooperation, (4.) forest certification, (5.) First Nations interests, and (6.) ecotourism.

The recovery of Pacific Water Shrew will also have socio-economic costs. Initially, the only economic sector anticipated to be significantly affected directly by this recovery process is land development for urban and rural uses. Potential costs identified include (1.) increased private land protection and management, (2.) costs of increased government management, and (3.) increased resources for ecological research. Because Pacific Water Shrew can be protected initially within existing policy limits for timber supply impacts from Wildlife Habitat Areas (WHAs), no anticipated reductions in timber harvest are necessary initially for this recovery process. Furthermore, only a small part of this species' known range is on Crown land that is managed for forestry, so no large timber supply impacts are expected through this recovery process.

Recommended Approach for Recovery Implementation

There are opportunities to integrate plans for Pacific Water Shrew with other conservation efforts in the region. Several species at risk overlap in range and preferred habitat characteristics with the Pacific Water Shrew, such as the Salish Sucker (*Catostomus catostomus*), Nooksack Dace (*Rhinichthys* sp.), and the Oregon Spotted Frog (*Rana pretiosa*). Protection of habitat for other species also might provide suitable living or corridor habitat for Pacific Water Shrew. To encourage landscape-level coordination among recovery efforts for species at risk in the lower mainland of B.C., the B.C. Ministry of Environment established the South Coast Conservation Program (SCCP) in partnership with The Land Conservancy, Fraser Valley Conservancy, Community Mapping Network, and the University of British Columbia.

Statement on Action Plans

An action plan for Pacific Water Shrew recovery is currently being drafted by the Pacific Water Shrew Recovery Team. The final action plan should be completed and approved by the Pacific Water Shrew Recovery Team within 2 years of the Recovery Strategy being posted on the SARA public registry.

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APPENDIX A**Area protected under approved (Aug 2007) Wildlife Habitat Areas.**

The areas listed in the table are based on the Wildlife Habitat Areas (WHA) Identified Wildlife Provisions requiring that the WHA should extend the entire length of the stream or wetland and include at least a 30-m-wide core area and an additional 45-m-wide management zone on each side of the stream or around wetland/wetland complex (i.e., a minimum 75-m-wide protected area; British Columbia Ministry of Water, Land and Air Protection 2004).

Name	WHA tag	Feature notes	Area (ha)
Pacific Water Shrew	2-140	WHA core area	11.7
		WHA management zone	8.7
		2-140 Total	20.4
	2-144	WHA core area	6.5
		WHA management zone	9.5
		2-144 Total	16.0
	2-147	WHA core area	3.5
		WHA management zone	5.4
		2-147 Total	8.9
Grand total			45.3
	Summary	Total core area	21.7
		Total management zone	23.6
Grand total			45.3

APPENDIX 2

Definitions of terms and acronyms

B.C.: British Columbia

BMP: Best management practices

COSEWIC: Committee on the Status of Endangered Wildlife in Canada www.cosewic.gc.ca/

Crepuscular: Most active around dawn and dusk

CWS: Canadian Wildlife Service

DFO: Department of Fisheries and Oceans Canada

DND: Department of National Defence

Extent of occurrence: Defined by COSEWIC as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon, excluding cases of vagrancy. Extent of occurrence as presented in this Recovery Strategy was measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeded 180 degrees and which contains all the sites of occurrence).

GVRD: Greater Vancouver Regional District

Historical range in Canada: Includes habitat where the species occurs naturally and where its presence is not likely due to recent effects of humans (currently occupied and ultimately suitable habitats). This area includes both areas where records of the species exist and adjacent areas that contain potential habitat. This area will be expanded as needed if new localities are discovered in other drainages.

MoE: B.C. Ministry of Environment

MOFR: B.C. Ministry of Forests and Range

MSRM: B.C. Ministry of Sustainable Resource Management

Nocturnal: Most active at night

PWS: Pacific Water Shrew

RENEW: Recovery of Nationally Endangered Wildlife/National Recovery Working Group

SARA: *Species at Risk Act*

Species: For the purposes of COSEWIC classification, any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora

Threatened: A species that is likely to become endangered if limiting factors are not reversed

Vagility: Propensity of an organism to move around a landscape

WHA: Wildlife Habitat Area

